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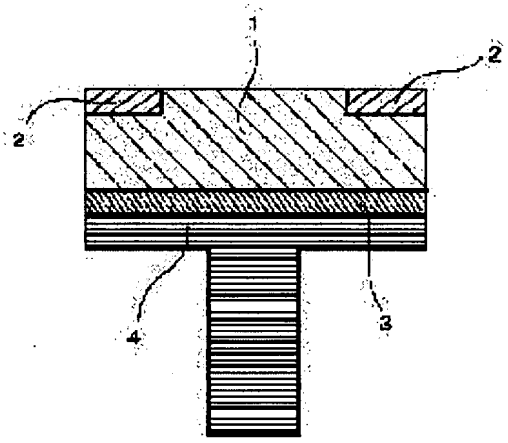
(54) ELECTRIC CONTACT AND ITS MANUFACTURE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electric contact suited for use in a breaker for 100A or less rated current.

SOLUTION: In this structure, a peripheral layer 2 having 135mHv or more micro Vickers hardness of a contact surface and a central layer 1 less than 135mHv micro Vickers hardness of a section are compounded. The peripheral layer 2 occupies a contact surface region of 32.7% or more 91.0% or less from a contact surface peripheral edge, in an electric contact, the central layer 1 and the peripheral layer 2 are composed of silver alloy 8.0% or more 25.0% or less cadmium(Cd), 1.1% or more 5% or less tin (Sn), 0.07% or more 3% or less nickel(Ni)



and 0.2% or less impurity element.

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CLAIMS

[Claim(s)]
[Claim 1] Electric contact to which the rated current is electric contact used for the breaker (breaker) below 100A (A), and a periphery stratification plane product is characterized by being 91.0% or less of structure 32.7% or more in a contact front face with the structure where the periphery layer of 135 or more mHvs of micro Vickers hardness and the central layer of less than 135 mHv of micro Vickers hardness were made to compound-ize, at least than a contact periphery edge.
[Claim 2] Electric contact according to claim 1 characterized by the layer of 135 or more mHvs of micro Vickers hardness being in said central layer.
[Claim 3] Electric contact according to claim 1 or 2 characterized by the thickness of said periphery layer being 5 micrometers or more on an average.
[Claim 4] Electric contact given in any 1 term of claims 1-3 to which cadmium (Cd) is characterized [said central layer and a periphery layer / nickel (nickel)] by an impure element being 0.2% or less of silver alloy by tin (Sn) 3% or less 0.07% or more 5% or less 1.1% or more 25.0% or less 8.0% or more by weight %.
[Claim 5] Electric contact given in any 1 term of claims 1-3 to which cadmium (Cd) is characterized [said central layer and a periphery layer / nickel (nickel)] by being 0.7% or less of silver alloy by tin (Sn) 0.22% or more 4% or less 1.2% or more 25.0% or less 8.0% or more by weight %.
[Claim 6] For 25.0% or less 14.0% or more, and tin (Sn), cadmium (Cd) is [electric contact used for the breaker (breaker) below 60A (A) of rated currents / 4% or less 2.4% or more, and nickel (nickel)] electric contact given in any 1 term of claims 1-3 to which it is characterized by being 0.24% or more 0.7% or less of silver alloy at weight %.
[Claim 7] Electric contact given in any 1 term of claims 4-6 characterized by 2% or less 0% or more, and cobalt (Co) being [antimony (Sb) / 2% or less 0% or more, and calcium (calcium) / 0.3% or less 0% or more, and a bismuth (Bi) / 0.5% or less 0% or more, and an indium (In)] 5% or less 0% or more of silver alloys for 1% or less 0% or more, and zinc (Zn) by weight %.
[Claim 8] The manufacturing method of electric contact given in any 1 term of claims 1-3 characterized by forming a depression in the outside of the field used as the central layer on said front face of a contact, carrying out thermal spraying of the silver alloy to this depression by the powder spraying process, and forming a periphery layer in it.
[Claim 9] The manufacturing method of electric contact given in any 1 term of claims 1-3 characterized by forming a depression in the outside of the field used as the central layer on said front face of a contact, vapor-depositing a silver alloy to this depression with vacuum deposition, and forming a periphery layer in it.
[Claim 10] The manufacturing method of electric contact given in any 1 term of claims 1-3 which form said central layer with the oxidized silver alloy chip, arrange the grain of the oxidized silver alloy which serves as a periphery layer on the outside of this chip, and are characterized by sintering after carrying out pressing.
[Claim 11] The manufacturing method of electric contact given in any 1 term of claims 1-3

characterized by fitting the silver alloy used as a periphery layer into the perimeter of the silver alloy which serves as a central layer which carried out annealing softening after soak cleaning, and unifying and carrying out homogenizing of a central layer and the periphery layer to an acidic solution.
[Claim 12] The manufacturing method of electric contact given in any 1 term of claims 1-3 which pierce the silver alloy plate with a (virgin silver Ag) layer used as the silver alloy plate used as said central layer, and a periphery layer, and are characterized by oxidizing after annealing.
[Claim 13] the hydrostatic molding (HIP) between the heat after fitting the silver alloy cylinder material used as a periphery layer into the perimeter of the silver alloy rod used as said central layer and carrying out airtight welding of the outside boundary section of this rod and this cylinder material -- the manufacturing method of electric contact given in any 1 term of claims 1-3 which form the bar of a composite construction by law and are characterized by starting a disc-like contact at a right angle, and oxidizing to the longitudinal direction of this bar.
[Claim 14] The manufacturing method of electric contact given in any 1 term of claims 1-3 which combine the silver alloy cylinder member which fabricated the grain of said silver alloy in the shape of a cylinder, form the cylindrical wire rod of a composite construction in the perimeter of the cylinder member which fabricated the grain of the silver alloy after oxidation used as said central layer by the hot extrusion processing method, and are characterized by starting a disc-like contact at a right angle, and oxidizing to the longitudinal direction of this wire rod.
[Claim 15] The manufacturing method of electric contact given in any 1 term of claims 1-3 characterized by forming the silver alloy ring-like member used as the silver alloy cylinder which serves as a central layer in a disc-like contact, and a periphery layer by the unification forging method, and oxidizing.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to electric contact used for the breaker for power distribution, an earth leakage breaker, a safety breaker, a circuit protector, etc.
[0002]
[Description of the Prior Art] Electric contact is used for the breaker (these are summarized henceforth and it is called a breaker) generally used for the breaker for power distribution, a no fuse breaker, an earth leakage breaker, a circuit protector, or a safety breaker and other panelboards. As electric contact for these breakers, Ag alloy is spent widely. The oxide dispersion-strengthening mold alloy which In oxide, Sn oxide, Cd oxide, Bi oxide, Co oxide, nickel oxide, Zn oxide, Sb oxide, calcium oxide, etc. distributed is widely used by this Ag alloy into Ag matrix.
[0003] As a property required of this electric contact, there are joining-proof [(1)] nature, the initial temperature characteristic of (2), the temperature characteristic after (3) overload tests, the temperature characteristic after (4) durability tests, the temperature characteristic, an insulating property after (5) blocking tests, etc.
[0004] And when the rated current is electric contact for the breakers below 100A, unlike electric contact for the breakers more than 225A in the rated current, electric contact itself is very small, and it is usually very small thin compared with the case where the area and thickness of electric contact are more than 225A. Moreover, although there are a mounting arrangement to the base material which supports electric contact, and a case of soldering like [in more than 225A], there are many cases of the caulking approach. In this case, it is not [a not granular contact configuration is also] like [in more than 225A] granular, and there is much difference, such as sticking with pure Cu and making it the bis-configuration which was put together. Moreover, in below 100A, the tooth space in a breaker also needs to make it small in many cases.
[0005] Therefore, the structure of the optimal contact for satisfying the demand characteristics and this like aforementioned [on the engine performance for which this electric contact is asked] (1) - (5), and an alloy presentation also differ from the case more than 225A, and the case below 100A. In view of the above fact, it aims at indicating electric contact suitable for the breaker application of 100 or less first class of rated currents by this application.
[0006] In addition, this application has a degree of hardness, the periphery layer which managed the arrangement gestalt, and a central layer, and can offer electric contact suitable for the breaker below rated current 100A which this application means for the first time by optimizing chemical composition. Therefore, unlike JP,62-97213,A which makes a conductive good ingredient the 2nd layer (lower layer), and makes the layer which consists of an ingredient with a high degree of hardness the 1st layer (upper layer), the 1st layer differs from JP,62-97213,A still like this JP,62-97213,A not from 2OAg-SnO2 and In3 system but from the point that the 2nd layer is not pure Ag, either.
[0007] Electric contact of the invention in this application is not what demonstrates the effectiveness most in the service condition below 60A also in below rated current 100A, and showed the contact of a

low loading application to pans, such as a relay. Moreover, in the central layer which this application shows, an improvement of the temperature characteristic and a periphery layer mainly aim at an improvement of the joining-proof engine performance.
[0008] When it follows, for example, the 1st layer (upper layer) is used as the conductor which has expendability-proof and joining-proof nature like JP,58-189913,A which is a well-known example and the piece of an arc uses the 2nd layer (lower layer) as a good conductor in a short-circuit current, it differs clearly, and it is not necessary to form irregularity in the interface of the 1st layer and the 2nd layer like this JP,58-189913,A in this application.
[0009] Moreover, in this application, a silver-lithium system and a silver-indium system are not used for the 2nd layer like this JP,58-189913,A, but this application is invention which is different from any well-known example with the purpose, a configuration, etc.
[0010]
[Problem(s) to be Solved by the Invention] The above (1) Among the contact demand characteristics of - (5), some have the relation of the property which conflicts mutually, for example, the temperature characteristic (the temperature rise by energization is so good that it is small) and a joining-proof property have the relation of a trade-off mutually. For this reason, in order to improve the temperature characteristic, a joining-proof property must be sacrificed. although the activity which selects the contact alloy which old electric contact examines each of the demand characteristics of these many, and has the optimal property combination was done -- (1) - (5) -- it was impossible on the relation of the above-mentioned trade-off to have selected the contact fully satisfied about all properties.
[0011] Especially, as a contact for breakers below 100A consisting mainly of the object for rated current 30A, and the object for 50A, coexistence of the temperature characteristic (they are the initial temperature characteristic and the temperature characteristic after an overload test especially) and a joining-proof property was difficult. For example, even if the joining-proof property was good, the initial temperature engine performance worsened and initial temperature (so good that it is low) changed into the large condition of the so-called variation that a high value is shown or the case of being good, and the case of being bad happen irregularly, in many cases.
[0012] That is, it was difficult for the rated current made especially into the object of the invention in this application to reconcile a joining-proof property and the temperature characteristic at below 100A, especially the contact for breakers of the rated currents 30A-50A. The reason was because the ideal contact alloy presentation and structure which are needed in order to satisfy each demand characteristics, respectively are not clarified while being that the development of the contact at which both properties which originally have the relation of a trade-off are satisfied itself is difficult.
[0013] For example, [how in the case of the contact for rated 50A, there should be a contact alloy presentation required for joining-proof nature amelioration and combination of structure, and] And [how there should be a contact alloy presentation required for improvement in the initial temperature characteristic and combination of structure, and] Moreover, it was not necessarily clear in the knowledge about differing how as compared with a contact alloy presentation required for a joining-proof property in case the rated current is 225A, and the initial temperature characteristic, and the optimal combination of structure.
[0014] Moreover, even if those ideal contact alloy presentations and structures are known Since it is difficult for one contact to have an ideal contact alloy presentation and structure of varieties required in order to satisfy each properties of those in coincidence, it compares further and it has, even if it invents the approach of making it compound-ize like this application It was unknown at what kind of rate those optimal combination, for example, which alloy and which alloy, is combined with what kind of condition and what kind of thing the manufacturing method was.
[0015]
[Means for Solving the Problem] It is the structure where the periphery of the central layer of less than 135 mHv of micro Vickers hardness was made to allot and compound-ize the periphery layer of 135 or more mHvs of micro Vickers hardness in electric contact of the invention in this application, and said periphery layer occupies 91.0% or less of contact surface field 32.7% or more from a contact surface

periphery edge. It is also useful that the layer of 135 or more mHvs of micro Vickers hardness is in said central layer.

[0016] The rated current in electric contact used for the breaker below 100A (A) 25.0% or less 8.0% or more, cadmium (Cd) by weight % [a central layer and a periphery layer] 3% or less 0.07% or more, nickel (nickel) 5% or less 1.1% or more [tin (Sn)] An impure element is the silver alloy with which tin (Sn) contains 4% or less 1.2% or more 25.0% or less 8.0% or more, and nickel (nickel) contains [cadmium (Cd)] 0.7% or less 0.22% or more desirably 0.2% or less.

[0017] By electric contact used for the breaker below 60A (A) of rated currents, by weight %, 25.0% or less, tin (Sn) uses 2.4% or more 14.0% or more, and nickel (nickel) uses [cadmium (Cd)] 0.7% or less of silver alloy 0.24% or more 4% or less.

[0018] Furthermore, it also has desirable antimony (Sb) that cobalt (Co) uses 0% or more 0% or more, and an indium (In) uses [calcium (calcium) / a bismuth (Bi) / zinc (Zn)] 5% or less of silver alloy 0% or more 0.5% or less 2% or less 1% or less 0% or more 0.3% or less 0% or more 2% or less 0% or more at weight %. In addition, the thing of the very thin thickness of 5 micrometers is [the thickness of a periphery layer] also effective, and there should just be 5 micrometers or more on an average.

[0019] How to form a periphery layer with a powder spraying process or vacuum deposition in the manufacturing method of electric contact of this application, Or form a central layer with the oxidized silver alloy chip, and the grain of the oxidized silver alloy which serves as a periphery layer on the outside of this chip is arranged. After carrying out pressing, after soak cleaning to the approach of sintering, and an acidic solution around the silver alloy used as the central layer which carried out annealing softening The silver alloy used as a periphery layer is fitted in, the silver alloy plate with a (virgin silver Ag) layer used as the approach of unifying and carrying out homogenizing of a central layer and the periphery layer, the silver alloy plate used as a central layer, and a periphery layer is pierced, and there is the approach of oxidizing after annealing.

[0020] Furthermore, the silver alloy cylinder material used as a periphery layer is fitted into the perimeter of the silver alloy rod used as a central layer. the hydrostatic molding (HIP) between the heat after carrying out airtight welding of the outside boundary section of this rod and this cylinder material -- the bar of a composite construction being formed by law, or The silver alloy cylinder member which fabricated the grain of said silver alloy is combined in the shape of a cylinder, and the cylindrical wire rod of a composite construction is formed in the perimeter of the cylinder member which fabricated the grain of the silver alloy after oxidation used as a central layer by the hot extrusion processing method.

[0021] And it is based on the approach of starting a disc-like contact at a right angle, and oxidizing at it to the longitudinal direction of said bar or a wire rod. Moreover, the approach of forming the silver alloy ring-like member used as the silver alloy cylinder which serves as a central layer in a disc-like contact, and a periphery layer by the unification forging method, and oxidizing is also effective. This application allots Ag alloy section of a high degree of hardness in a surrounding periphery layer for the purpose of improving the temperature characteristic, with high joining-proof nature maintained, shows how to arrange Ag alloy with a low degree of hardness in a central layer, and shows the optimal alloy presentation in this structure further. That is, if it is the usual contact which is not made into a composite construction like this application, the temperature characteristic will become very bad, though the joining-proof engine performance of Cd concentration is [8.0% or more 25.0% or less and Sn concentration] good when 1.2% or more 4% or less and nickel concentration become 0.7% or less 0.22% or more (a temperature rise becomes very high).

[0022] In the contact of the structure which this application shows, since it is effective in a layer with the low degree of hardness of a center section improving the temperature characteristic, the temperature characteristic can acquire the good temperature characteristic at the time of high-concentration Cd and Sn for which only a part to be improved by this central layer cannot necessarily say the temperature characteristic with it being good, and nickel content.

[0023] Thus, it enables it to, acquire a high joining-proof property on the other hand at this application by setting a contact alloy presentation as high Cd, Sn, and nickel concentration, the temperature characteristic filling demand characteristics with a composite construction. That is, at least a composite

construction cannot demonstrate sufficient effectiveness which this invention takes also only by making it the presentation range in which this invention does not demonstrate sufficient effectiveness, and this application shows a contact alloy presentation. If a contact alloy presentation is not made into the above-mentioned range even if it makes it a composite construction, even if it does not realize a high joining-proof property but makes only a contact alloy presentation into the presentation range of this application on the other hand, the temperature characteristic which was excellent if not considered as a composite construction is not realized.

[0024] Therefore, in this application, a contact alloy presentation and the combination of a composite construction have the relation which fills up the property which should be improved to mutual [very important], and suits. Neither the contact alloy presentation which this application clarifies, nor the optimal range of a composite construction is what chose each value as arbitration, and is clarified as a result of research of the contact alloy presentation range which shows the property which was excellent in the case of that composite construction after showing clearly that it has the relation for which a composite construction and a contact alloy presentation depend on this appearance mutually.

[0025]

[Embodiment of the Invention] Especially this application indicates the result to which the rated current mainly considered the ideal composite construction and a contact alloy presentation below 100A about electric contact suitable for the breaker of 30A-60A. However, the contact cannot be used for the breaker of rated current 225A or 400A.

[0026] The artificer found out that it was good to make structure of a contact into the composite construction which allotted the periphery layer 2 to the periphery of the central layer 1 like drawing 1 , as a result of mainly searching for a contact alloy presentation and structure optimal as a contact for below 100A. As shown in drawing 2 , there may be a pure Ag layer in a field opposite to the contact front face of this composite construction. A layer is not prevented from this being used in order that this pure Ag layer may improve soldering nature, and this application having.

[0027] Moreover, like drawing 1 or drawing 2 , periphery layer 2 thickness may be the same as a central layer, and the periphery layer 2 may be only in the surface section 8 like drawing 3 (a) and drawing 3 (b). For example, you may be the thickness of the one half (1/2) of contact thickness. When arranging a periphery layer only in the surface section 8 like drawing 3 , it is desirable the thickness of an average of 5 micrometers or more and for this periphery layer to have the thickness of 10 micrometers or more more desirably. It is because it will be hard coming to accept the effectiveness which allotted the periphery layer if this has thin thickness, and as a result of an experiment, even if the effectiveness does not necessarily exist, there is little the effectiveness and it is desirably required of less than 5 micrometers 10 micrometers or more.

[0028] Since a breaker is characteristic with a model (spring pressure, tripping force, etc.), that effectiveness is accepted even if it is less than 5 micrometers that it is hard to decide that it is bad, if the contact thickness of this periphery layer is not generally what micrometer. However, in many cases, it was desirable that there were 5 micrometers or more, and the effectiveness of this application was more effectively accepted in 10 micrometers.

[0029] Moreover, as shown at drawing 3 (b) in the central layer which is less than 135 mHv of micro Vickers hardness, the layer 1-1 of 135 or more mHvs of micro Vickers hardness may exist in the one section in 70% or less of range of a central layer. This is because it turned out that the effectiveness that the central layer of less than 135 mHv of micro Vickers hardness exists may not be lost, and joining-proof nature may improve by the case when it was this within the limits.

[0030] The example (drawing 4 , 5, 6, 7) which has Cu screw section 4 in the lower part of electric contact was shown. Electric contact with Cu screw section is combined with the base material 7 as the rated current generally widely used below by 100A, for example, shown in drawing 8 with caulking in many cases. It may not be, and it may have the influence for the contact engine performance with this big Cu screw section, or there may be. [no]

[0031] In drawing 1 -7, electric contact of the invention in this application allots the periphery layer 2 of 135 or more mHvs of micro Vickers hardness to the periphery of the central layer 1 of less than 135

mHv of micro Vickers hardness, it is the structure made to compound-ize so that a contact front face may turn into a flat surface, and this periphery stratification plane product occupies 91.0% or less of field 32.7% or more from the periphery edge on the front face of a contact.
[0032] Since it is hard coming to accept the effectiveness which allotted the periphery layer as this periphery layer is less than 32.7%, the joining-proof engine performance and a part of temperature characteristics worsen. Conversely, if 91.0% is exceeded, the temperature characteristic will worsen. It is more preferably [less than 69.8% 32.7% or more of] good. It is because joining-proof and the temperature characteristic by which this range was stabilized more are acquired. For Cd, 8.0%or more 25.0% or less and Sn are [1.1%or more 5% or less and nickel of both contact alloy presentations of a central layer and a periphery layer] 3% or less 0.07% or more in weight %. (% is weight %.) It is below the same.
[0033] Moreover, the part which the oxide which manufacture becomes impossible easily and is called condensation deposited is not [that it is easy to generate inside a contact] desirable on the temperature characteristic of a contact as joining-proof nature becomes it low that Cd concentration is less than 8.0% and Cd concentration becomes high about this contact alloy presentation exceeding 25.0%.
[0034] If joining-proof nature is low in Sn concentration being less than 1.1% and 5% is exceeded, the initial temperature characteristic and the temperature characteristic after an overload test will deteriorate among the temperature characteristics. About nickel, if joining-proof nature is low in it being less than 0.07% and 3% is exceeded, manufacture will become difficult and the temperature characteristic will worsen. It is desirable for 8.0%or more 25.0% or less and Sn to be [for 1.2%or more 4% or less and nickel] 0.7% or less 0.22% or more especially for Cd.
[0035] In addition, as electric contact for breakers of a below rated current 60A class, although the temperature characteristic will deteriorate somewhat if Sn makes 2.4% or more 14.0% or more and nickel makes it to 0.7% or less 0.24% or more 4% or less 25.0% or less, Cd becomes high and a joining-proof property has it in the breaker of this class. [optimal]
[0036] moreover, joining-proof nature and Sb added for a temperature characteristic improvement -- 0% or more 0.5% or less and In have [0%or more 1% or less and Zn / 0%or more 2% or less and Co] 0% or more 5% or less of range good [0%or more 2% or less and calcium / 0%or more 0.3% or less and Bi]. As long as these elements had the concentration of Cd, Sn, and nickel in the above-mentioned range fundamentally, it turned out that the contact engine performance suitable for the breaker below 100A which this application means is expectable.
[0037] Of course, if the value of standard (above-mentioned temperature and value of standard of the joining-proof engine performance) in the performance evaluation of a breaker is eased For example, although it knows that it can be used even if it is a value exceeding that it may be equal to use even if Sn concentration is a value exceeding less than 1.1% and 5%, and an artificer can also become the appearance, less than 1.1%, and 5% I think it desirable that a breaker is important equipment on insurance, or that it is the above-mentioned Sn range too when it is taken into consideration in real use that variation exists in any products. The same thing is applied also about Cd and nickel.
[0038] Although the content element of a contact is an element like the above, even if it adds elements other than Cd, Sn, nickel, Sb, calcium, Bi, Zn, Co, and In in a minute amount, when it is made the composite construction which this application shows, it can be going to just imagine that the same effectiveness is expectable generally easily. Conversely, if it says, this application does not forbid adding additional trace elements to extent which does not spoil the effectiveness which this application takes in the range of a contact alloy presentation of the contact structure which this application shows, and Cd, Sn and nickel.
[0039] Cd, Sn, nickel, Sb, calcium, Bi, Zn and Co of a periphery layer, and In concentration are [be / it / higher than the concentration of a central layer] good in it being low, as long as it is within the limits of the 4th term of a claim - the 7th term. Moreover, it is not necessary to use the expensive element like Au for the surface section.
[0040] furthermore, about the approach of compounding the periphery layer 2 and the central layer 1 It inserts in after thermal spraying of a under [vacuum evaporationo and reduced pressure], powdered

sintering, and acid cleaning and annealing. A doubling method, How to fabricate the plate which should serve as a plate which should serve as a periphery layer, and a central layer by punching, Even if it uses the approach and ****** which are fabricated by forging in a contact configuration after producing separately the approach, periphery layer, and central layer by HIP and extrusion, the structure of a contact and an alloy presentation can expect the same effectiveness, as long as it is in the range of the structure which this application shows, and an alloy presentation.

[0041] In addition, although the same effectiveness is expectable as long as it carries out, eye ** and plating are also considered and the range of the approach of joining by micro welding, a shrink fitting and the cold, the structure that this application shows, and an alloy presentation has the structure of a contact, and an alloy presentation like the above after producing a periphery layer and a central layer separately It is not necessarily desirable from the field of mass-production nature being missing from a viewpoint of mass-producing cheaply the product by which cost and quality were stabilized, and maintaining the detergency of a junction interface.

[0042] In addition, although the loose concentration gradient which goes to the interior from a front face is generally looked at by the contact which generally carried out internal oxidation They are not that the composite construction of this application is natural, among these the thing which shows the general concentration gradient looked at by section oxidation. Even if it is the case where the periphery layer 2 is formed only near the front face like drawing 3 , drawing 6 , and drawing 7 even if there is change of the continuous degree of hardness in the several micrometer piece boundary section and an organization in an interface with the central layer 1, for example in the organization observation by an optical microscope etc., the difference in an organization which is clearly different in the periphery layer 2 and the central layer 1, and the difference in the degree of hardness in micro Vickers are presented.

[0043] Although it is desirable that it is 5 micrometers or more on an average as for the thickness of this periphery layer when a periphery layer does not spread near the front face of a contact like drawing 3 and drawing 6 , a periphery layer will be very thin in this case. However, in this application, a periphery layer at least does not point out Ag plating performed to a pole front face several micrometers or less all over a contact side for example, from a contact front face. This application is the object which made the layer with a high (135 or more mHvs) degree of hardness form only in the periphery section, and differs from the above-mentioned plating fundamentally.

[0044] However, it is an industrial product, and it does not matter even if there is a concentration gradient as which an alloy presentation and an organization are regarded by general internal oxidation material in each of a periphery layer and a central layer from the semantics that change of some concentration gradients, or an organization and a degree of hardness is what is seen in any contacts. In 135 or more mHvs and a central layer, a periphery layer may have the inclination of the degree-of-hardness distribution accompanying a concentration gradient, as long as the range also of the inclination of the degree-of-hardness distribution accompanying a concentration gradient is less than 135 mHvs.

[0045] Moreover, in order to join copper base metal and Ag alloy in the production process of the contact of a bis-configuration as a conventional example, heat treatment which lets the inside of a furnace pass may be performed. In this case, Cd near the front face of Ag alloy may dissipate all over a furnace, for this reason a surface degree of hardness may become low somewhat. In such a case, usually it is difficult to manage degree-of-hardness arrangement of a central layer, degree-of-hardness distribution of a periphery layer and a central layer as this application shows, and a periphery layer, and since it is not a low value as this application also indicates the degree-of-hardness value to be, it differs from what this application means.

[0046] Even if 1% or less 0% or more, and Zn are [Sb / 2% or less 0% or more, and calcium / 0.5% or less 0% or more, and In of 2% or less 0% or more, and Co] Ag alloys of 5% or less 0% or more of range in this application for 0.3% or less 0% or more, and Bi An element is not prevented from other being added the same with not interfering, as long as it belongs to the range according to claim 7.

[0047] Ce usually added 5% or less 0.001% or more so that it may furthermore be a well-known example, Sb added 6.2% or less 0.1% or more, Li added 5% or less 0.01% or more, Si added 10% or less 0.05% or more, Fe added 0.5% or less 0.01% or more, Pb added 0.1% or less 0.05% or more, Cr

and Sr which are added 5% or less 0.001% or more, Ti added 5% or less 0.5% or more, Te added 5% or less 0.5% or more, It does not bar adding Mn added 5% or less 0.5% or more, AlF3 and MgF2 which are added 3% or less 0.01% or more, CrF3 and CaF2, germanium and Ga which are added 3% or less 1% or more, and Mg added 0.1% or less 0.01% or more. In the limitation in the range of a configuration of indicating to a claim also in these cases, it is because the same effectiveness as the case where these elements cannot be found is expectable, and is because it is not that to which this application bars mixing these other elements with extent which does not spoil the useful effectiveness of this application.

[0048] (Example 1) 1mm in 4mm long, 4mm wide, and thickness, 4mm long, 4mm wide, a pair with a thickness of 1.2mm (it corresponds to the traveling contact 5 and stationary contact 6 of drawing 8 .) in addition, drawing 1 -7 show the stationary contact on explanation -- the depression (a periphery layer rate is also shown in Tables 5 and 6 as a field of this depression.) of the vacuum evaporationo stratification section where all of electric contact are carried out with [of thickness / 10% of] a pure Ag layer, and serve as a periphery layer -- 0.8mm depth -- carrying out -- a contact alloy presentation -- Tables 1 and 2 (the publication with "PU" corresponds to the column of an approach.) The same is said of Tables 3-6. A contact central layer which becomes was produced, thermal spraying of Table 3 and the alloy powder of a presentation of four was carried out to the front face (pure Ag is the field of the opposite side) in the ambient atmosphere of an argon and hydrogen gas (Ar+H2) by the low-pressure-plasma-spraying method, and the periphery layer was formed in it. In addition, similarly the contact alloy presentation of a central layer and Table 2 are the contact alloy presentations of a central layer, and Table 1 shows the example of a comparison.

[0049]

[Table 1]

	Cd wt%	Sn wt%	Ni wt%	Sb wt%	Ca wt%	Bi wt%	Zn wt%	Co wt%	In wt%	方法
(1)	8.2	1.1	0.07	0	0	0	0	0	0	ﾌﾟ･蒸
(2)	25.0	4.5	3.0	2	0.3	1.0	1.0	0.3	5	粉
(3)	19.5	1.3	0.24	0	0	0	0	0	0	酸+焼
(4)	16.0	3.8	0.7	0	0	0	0	0	0	板
(5)	13.8	2.5	0.24	0	0	0	0	0	0	HIP
(6)	13.0	1.3	0.26	0	0	0.8	0.1	0.1	0	押出
(7)	14.0	2.5	0.24	0	0	0	0	0	0	鍛
(8)	23.0	3.7	0.6	0	0	0	0	0	5	HIP
(9)	14.0	4.5	0.5	0	0	0	0	0	0	HIP
(10)	8.0	1.2	0.5	0	0	0	0	0	0	HIP

[0050]

[Table 2]

	Cd wt%	Sn wt%	Ni wt%	Sb wt%	Ca wt%	Bi wt%	Zn wt%	Co wt%	In wt%	方法
(11)	23.5	1.3	0.06	0	0	0	0	0	0	プ
(12)	7.5	1.4	0.2	0	0	0	0	0	0	酸+焼
(13)	16.1	2.0	3.2	0	0	0	0	0	0.5	HIP
(14)	12.5	5.8	0.08	0	0.06	0	0	0	0.3	HIP
(15)	14.8	0.9	0.3	1.0	0	0	0	0	0	HIP
(16)	25.5	2.0	0.3	0	0	0	0	0	0	HIP

[0051] Powder particle size used the powder from 1 micrometer or less to 2 micrometers for the raw material using the end of pre-alloyed powder. Ar was used for the carrier gas for feed. Moreover, while making the tip of a thermal spraying gun rock in automatic control during thermal spraying and aiming at formation of a homogeneity thermal-spraying layer, the substray was put to plasma evil and thermal spraying was performed after heating in order to raise the adhesion of the interior layer of electric contact which becomes a substray, and a thermal-spraying layer. In order not to carry out thermal spraying to central layers other than a depression part so that it may be easy to prepare a thermal-spraying layer in a depression part namely, it masked to central layers other than a depression part. In addition, the contact alloy presentation of a periphery layer and Table 4 are the same, and Table 3 shows the contact alloy presentation (example of a comparison) of a periphery layer.

[0052]

[Table 3]

	Cd wt%	Sn wt%	Ni wt%	Sb wt%	Ca wt%	Bi wt%	Zn wt%	Co wt%	In wt%	方法
A-1	8.1	1.5	0.08	0	0	0	0	0	0	プ
-2	8.1	1.1	0.07	0	0	0	0	0	0	蒸
B	25.0	4.5	3.0	2	0.3	1.0	1	0.3	5	粉
C-1	25.0	1.4	0.3	0	0	0	0	0	0	酸+焼
-2	8.3	1.3	0.24	0	0	0	0	0	0	酸+焼
D-1	16.0	3.8	0.7	0	0	0	0	0	0	板
-2	12.0	2.5	0.25	0	0.2	0	0	0.3	3	酸+焼
E-1	14.0	2.8	0.3	0.9	0	0	0	0	0	HIP
-2	24.5	1.4	0.4	0	0	0	0	0	0	プラス
F-1	15.1	1.9	0.34	0	0	0	0	0.1	0	押出
-2	15.1	1.2	0.6	0	0	0.8	0	0.1	0	酸+焼
G	14.0	2.5	0.24	0	0	0	0	0	0	鍛
H	24.7	3.5	0.6	0	0	0	0	0	3	HIP
-2	14.0	3.5	0.4	0	0	0	0	0	1.0	蒸着
I-1	14.0	4.5	0.5	0	0	0	0	0	0	押出
-2	14.0	1.1	0.5	0	0	0	0	0	1.0	蒸着
J	8.0	1.2	0.5	0	0	0	0	0	0	押出

[0053]

[Table 4]

	Cd wt%	Sn wt%	Ni wt%	Sb wt%	Ca wt%	Bi wt%	Zn wt%	Co wt%	In wt%	方法
K	7.0	1.5	0.4	0	0	0	0	0	0	粉
L	15.0	0.05	0.12	0	0	0	0	0.1	0	ブ
M	16.1	1.8	0.06	0	0	0	0	0	3	粉
N	13.0	6.5	0.29	0	0	0	0	0	0.4	粉
O	14.0	4.0	3.5	0	0	0	0	0	0	HIP
P	25.5	3.8	2.0	0	0	0	0	0	0.3	HIP

[0054] The structure and the degree of hardness of electric contact after the oxidation acquired as a result are as in Tables 5 and 6. The result of having evaluated the temperature characteristic after a blocking test, and an initial thermometry and an overload test, the temperature characteristic after a durability test, and the temperature characteristic after a short-circuit test for these contacts by breaking current (220V and 5kA) in the breaker below rated 100A is shown in Table 5 (evaluation result of the invention in this application), and Table 6 (evaluation result of the example of a comparison). In addition, the column of H (*) display of Table 5 is the case where it is the three-tiered structure to which 10% of fields of 135 or more mHvs of micro Vickers hardness exists in the inside of a central layer.
[0055]
[Table 5]

外周	中央	方法	平均外周層厚(μm)	135 mHv以上外周層割合(%)	中央層の硬度(mHv)	Cuﾋﾟｽ部	耐溶着性	初期温度	急熱後温度	耐久後温度	短絡後温度
A-1	(1)	プ	25	49.6	88	無	3	4	4	3	3
-1	(1)	プ	30	51.0	88	有	3	4	4	3	3
-2	(1)	蒸	28	55.1	89	有	3	4	4	3	3
B	(2)	粉	後点厚み	52.4	112	無	4	3	3	3	3
C-1	(3)	圧+焼	75	53.8	78	無	4	4	4	4	4
-2	(3)	圧+焼	49	82.4	89	有	4	3	3	4	3
D-1	(4)	板	220	73.0	89	有	5	3	3	4	3
-2	(4)	圧+焼	77	62.8	88	無	5	3	3	4	3
E-1	(5)	HIP	後点厚み	43.8	89	有	4	4	4	4	3
-2	(5)	プ	340	83.2	89	無	4	4	4	4	4
F-1	(6)	押出	後点厚み	45.2	102	有	4	4	4	4	4
-2	(6)	圧+焼	60	39.2	96	無	4	4	4	5	4
G	(7)	鍛	240	76.0	78	有	5	3	4	4	4
H	(8)	HIP	後点厚み	69.8	105	無	3	3	4	3	4
H(*)	(8)	HIP	後点厚み	69.7	106	有	4	3	4	4	4
-2	(8)	蒸着	11	34.4	99	無	3	4	3	3	3
I-1	(9)	押出	後点厚み	49.6	79	無	4	3	3	3	3
-2	(9)	蒸着	7	57.8	89	無	4	3	3	3	3
-2	(9)	蒸着	4	75.0	89	無	4	3	3	3	3
J	(10)	押出	後点厚み	48.2	101	有	3	4	4	4	4

[0056]
[Table 6]

外周	中央	方法	平均外周層厚(μm)	135 mHv以上外周層割合(%)	中央層の硬度(mHv)	Cuヒゞス部	耐溶着性	初期温度	過負荷後温度	耐久後温度	短絡後温度
K	(1)	粉	接点厚み	61.6	88	有	2	3	3	3	2
L	(2)	プ	50	61.6	112	無	2	3	3	2	3
M	(3)	粉	接点厚み	39.2	87	無	2	3	3	3	3
N	(3)	粉	接点厚み	42.2	130	有	4	2	2	2	2
O	(3)	HIP	接点厚み	56.4	136	無	4	2	1	2	2
P	(3)	HIP	接点厚み	69.8	139	無	3	1	1	2	1
A-1	(11)	プ	68	49.6	79	有	2	3	3	2	3
A-2	(12)	蒸+焼	45	69.8	78	無	2	3	3	3	3
A-1	(13)	蒸	21	46.7	79	有	4	2	2	2	1
A-2	(14)	HIP	接点厚み	56.4	86	有	4	2	2	2	2
A-2	(15)	HIP	接点厚み	56.4	86	無	2	3	3	3	2
A-2	(16)	HIP	接点厚み	55.1	80	有	3	2	2	2	2
G	(7)	鍛	240	93.0	78	有	2	2	3	3	3
G	(7)	鍛	240	29.4	78	有	2	2	3	3	3
G	(7)	板	250	60.3	138	有	4	2	2	3	3
A-1	(1)	プ	25	49.6	88	無	2	3	4	3	3
定格 225A で評価											

[0057] Overload-test conditions were made into 6 times of the rated current, and the durability test performed 5000 trials in the rated current 50 times. As shown in drawing 4 , when evaluation was performed with Cu screw section, Cu screw section was produced by the direct junction by soldering or heating, and pressurization. In addition, since an evaluation result changed with evaluation breakers, it showed comprehensive evaluation by 5-1. 3 shows 5 and an usable minimum and 1 shows the most inferior result for the result of having excelled most.

[0058] (Example 2) 1mm in 4mm long, 4mm wide, and thickness, 4mm long, 4mm wide The depression of the vacuum evaporationo stratification section of electric contact of a pair with a thickness of 1.2mm and electric contact of the with a diameter thickness [1.5mm thickness of 6mm] same magnitude pair which carries out all with [of thickness / 10% of] a pure Ag layer respectively, and serves as a periphery layer is established in 50-micrometer depth, and they are Tables 1 and 2 ("**" and a publication correspond to the column of an approach.). The same is said of Tables 3-6. On the front face (pure Ag is the field of the opposite side) of the contact base material used as the internal layer of the contact which has a contact alloy presentation, it vapor-deposited by the magnetron sputtering method using the target which has the contact alloy presentation of Tables 3 and 4.

[0059] The temperature of a base material 7 was held at 200 degrees C, in order to prevent the reevaporation of Sn, and it kept the pressure at several 10torr (torr) from several torr (torr) in Ar ambient atmosphere. Moreover, in order to improve adhesion of the interior of a contact which is a base material, and the periphery layer which is a vacuum evaporationo layer, the front face of the contact base material which serves as a contact central layer beforehand vapor-deposited, after cleaning with the ion generated by the RF. After oxidizing the acquired contact, the result of having evaluated the temperature characteristic after the blocking test of the same conditions as an example 1, an initial thermometry, and an overload test, the temperature characteristic after an overload test, and the temperature characteristic

after a short-circuit test for these contacts was shown in Tables 5 and 6 with the degree of hardness.
[0060] (Example 3) contact alloy presentations are Tables 1 and 2 ("powder" and a publication correspond to the column of an approach.). The same is said of Tables 3-6. After producing Ag alloy chip 10 (it carried out to 10% of thickness when the pure Ag layer 11 was allotted) equivalent to the central layer shown in drawing 9 and carrying out it after oxidation so that it may become, Table 3 and Ag alloy grain 9 equivalent to the periphery layer after oxidation of a presentation (the same presentation as Tables 1 and 2) of four were arranged on the outside, and it sintered at the temperature of 30K under the melting point after pressing and in a vacuum ambient atmosphere. Coining was performed to the obtained compound alloy chip 12, and it annealed at about 650 degrees C. This produced electric contact of a pair with 1mm in 4mm long, 4mm wide, and thickness, 4mm long, 4 widemm, and a thickness of 1.2mm.
[0061] The result of having evaluated the temperature characteristic after the blocking test of the same conditions as an example 1, an initial thermometry, and an overload test, the temperature characteristic after an overload test, and the temperature characteristic after a short-circuit test for these contacts is shown in Tables 5 and 6 with a degree of hardness.
[0062] (Example 4) Tables 1 and 2 (a "acid + glow" and a publication correspond to the column of an approach.) used as central layer The same is said of Tables 3-6. It annealed and the alloy was made soft, after having soaked the member with the pure Ag layer of a presentation in the acidic solution, removing surface dirt and making it clarification. After producing, inserting in and uniting with the surroundings of this the member of the shape of a ring from which a contact alloy presentation should serve as a periphery layer which becomes Tables 3 and 4, it annealed further and unified by diffusion.
[0063] The structure and the degree of hardness of a composite contact after the oxidation acquired as a result were shown in Tables 5 and 6. The same conditions as an example 1 estimated the temperature characteristic after a blocking test, and an initial thermometry and an overload test, the temperature characteristic after an overload test, and the temperature characteristic after a short-circuit test for these contacts.
[0064] (Example 5) contact alloy presentations are Tables 1 and 2 (a "plate" and a publication correspond to the column of an approach.). The same is said of Tables 3-6. Ag alloy plate with a pure Ag layer which should serve as a central layer which becomes was produced, and it was pierced and processed with Table 3 and the alloy plate of a presentation of four, and formed in the alloy of a composite construction which consists of a central layer and a periphery layer. In addition, from the central layer, 30%, the periphery layer made the training ratio high and forged it. Annealing was performed at the temperature of 700 degrees C after that for 5 hours.
[0065] The structure and the degree of hardness of a contact of a composite construction which oxidized after that and were obtained were shown in Table 3. The same conditions as an example 1 estimated the temperature characteristic after a blocking test, and an initial thermometry and an overload test, the temperature characteristic after an overload test, and the temperature characteristic after a short-circuit test for these contacts.
[0066] (Example 6) contact alloy presentations are Tables 1 and 2 ("HIP" and a publication correspond to the column of an approach.). The same is said of Tables 3-6. The silver alloy rod 13 which should serve as a central layer which becomes was produced, it oxidized, Table 3 and the silver alloy cylinder material 14 of a presentation of four were fitted into the front face, and the outside boundary section 16 of a silver alloy rod and silver alloy cylinder material was made airtight by welding. The member 15 which fitted in is shown in drawing 10 (a). Then, the pressure of 1800kg/cm2 and the conditions of 2 hours performed HIP in Ar gas at the temperature of 700 degrees C, and the bar of a composite construction was obtained.
[0067] This is cut from a direction perpendicular to a longitudinal direction, and the finishing pure Ag layer was stuck on the disc-like contact. The same conditions as an example 1 estimated the temperature characteristic after a blocking test, an initial thermometry, and an overload test, the temperature characteristic after an overload test, and the temperature characteristic after a short-circuit test for this disc-like contact.

[0068] Moreover, after fitting in and making airtight beforehand the silver alloy rod 13-1 by welding into the silver alloy cylinder material 14-1 apart from this, the same conditions as an example 1 estimated similarly the member 15-1 (shown in drawing 10 (b).) into which it fitted into the silver alloy cylinder material 14, and 3-fold structure made airtight by welding fitted.
[0069] (Example 7) , next a contact alloy presentation are Tables 1 and 2 ("extrusion" and a publication correspond to the column of an approach.). The same is said of Tables 3-6. The cylinder billet with a diameter [of 80mm] and a die length of 200mm which combined the cylinder member 18 which fabricated and produced Ag alloy grain which oxidized the cylinder member 17 which should serve as the central layer 1 as shown in drawing 11 , and fabricated and produced oxidized Ag alloy grain which should serve as Table 3 and the periphery layer 2 of a presentation of four to the perimeter in the shape of a cylinder was produced.
[0070] After having performed the heating back in Ar ambient atmosphere, and the conditions of 2 hours having performed extrusion between heat at the temperature of 800 degrees C after that and considering as the cylindrical wire rod 19, it cut in the direction perpendicular to the longitudinal direction of the cylindrical wire rod 19, and the disc-like contact was produced. It oxidized, after making the pure Ag lamellae of 1 (1/10)/10 of the thickness of the thickness of this disc-like contact rival, and the contact with a diameter [of 5mm] and a height of 1.5mm was produced. The same conditions as an example 1 estimated the temperature characteristic after a blocking test, and an initial thermometry and an overload test, the temperature characteristic after an overload test, and the temperature characteristic after a short-circuit test for the contact.
[0071] (Example 8) , next a contact alloy presentation are Tables 1 and 2 ("**" and a publication correspond to the column of an approach.). The same is said of Tables 3-6. The cylinder 21 (with [of 12% of thickness of height] the pure Ag layer 22) as shown in drawing 12 which should serve as a central layer of a presentation, The ring-like member 20 (the shape of a ring with the same outer diameter as a cylinder 21) which should serve as a periphery layer of the chemical composition of Tables 3 and 4 was used as the disc-like contact of the diameter of 6mm, and a height 1.8mm configuration which the pure Ag layer 22 entered in the center of the ring-like member 20 with forging, and was unified.
[0072] The conditions same after oxidizing this disc-like contact as an example 1 estimated the temperature characteristic after a blocking test, and an initial thermometry and an overload test, the temperature characteristic after an overload test, and the temperature characteristic after a short-circuit test.
[0073] The result of a trial of these examples 1-8 is shown in Tables 1-6 with the example of a comparison. Namely, the thing in which the contact alloy presentation of a central layer has separated from the example of a comparison of Table 2 ((11) - (16)) from this invention, the thing and the example of table 6 comparison for which the contact alloy presentation of a periphery layer has separated from the example (K-P) of a comparison of Table 4 from this invention -- six of the start -- the contact alloy presentation of a periphery layer -- the following six -- periphery thickness and a degree of hardness separate from the following three, and the rated current of evaluation has separated [the contact alloy presentation of a central layer] from the last example of a comparison from this invention. As a result, the contact shown in this invention showed the temperature characteristic and the joining-proof property of having excelled clearly compared with the example of a comparison.
[0074]
[Effect of the Invention] This application can offer the contact having the outstanding temperature engine performance (after the first stage, an overload test, a durability test, and a short circuit blocking test), and the outstanding joining-proof engine performance with the structure (a degree of hardness is included.) suitable for using for electric contact below rated current 100A, and a contact alloy presentation.

[Translation done.]